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Towards the impact of eddies on the response of the global ocean circulation to Southern Ocean gateway opening

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During the past 65 Million (Ma) years, Earth's climate has undergone a major change from warm "greenhouse" to colder "icehouse" conditions with extensive ice sheets in the polar regions of both hemispheres. The Eocene-Oligocene ($\sim$34 Ma) and Oligocene-Miocene ($\sim$23 Ma) boundaries reflect major transitions in Cenozoic global climate change. Proposed mechanisms of these transitions include reorganization of ocean circulation due to critical gateway opening/deepening, changes in atmospheric CO_2-concentration, and feedback mechanisms related to land-ice formation. A long-standing hypothesis is that the formation of the Antarctic Circumpolar Current due to opening/deepening of Southern Ocean gateways led to glaciation of the Antarctic continent. However, while this hypothesis remains controversial, its assessment via coupled climate model simulations depends crucially on the spatial resolution in the ocean component. More precisely, only high-resolution modeling of the turbulent ocean circulation is capable of adequately describing reorganizations in the ocean flow field and related changes in turbulent heat transport. In this study, for the first time results of a high-resolution (0.1° horizontally) realistic global ocean model simulation with a closed Drake Passage are presented. Changes in global ocean temperatures, heat transport, and ocean circulation (e.g., Meridional Overturning Circulation and Antarctic Coastal Current) are established by comparison with an open Drake Passage high-resolution reference simulation. Finally, corresponding low-resolution simulations are also analyzed. The results highlight the essential impact of the ocean eddy field in palaeoclimatic change.